A Critical Review of "The High Costs of Federal Energy Efficiency Standards for Residential Appliances"

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In December 2003, the Cato Institute's publication Policy Analysis presented a paper by consulting economist Ronald Sutherland that criticized a study by the Energy Efficiency Standards Group at LBNL on the past and future impacts of federal appliance energy efficiency standards.[1] The LBNL study estimated that residential energy efficiency standards that became effective in the 1990-2001 period or will take effect by the end of 2007 will have a cumulative net present value of consumer benefit amounting to nearly $80 billion by 2015, and $130 billion by 2030. Sutherland claims that "correction of errors [in the LBNL calculations] suggests that the DOE's appliance energy efficiency standards will actually cost consumers a net $46.4 to 56.2 billion through 2050." A review of Sutherland's paper shows that:

(1) Sutherland's assumption that standards have saved and will save only half as much as estimated by LBNL is based on a misreading of actual trends in appliance efficiency and on inappropriate use of an econometric analysis of appliance efficiency.

(2) Sutherland's application of discount rates ranging up to 35% contradicts the guidance on cost-benefit analysis from the federal OMB, and has very little support in the mainstream economic literature.

(3) Sutherland makes a basic error of reasoning in his calculations: he reduces the savings from standards estimated by LBNL by 50% (suggesting that many consumers would have bought more efficient appliances without standards), but he does not make a corresponding adjustment in the consumer investment in efficiency. That is, his calculation implies that standards were not responsible for much of the purchase of more efficient appliances, but he charges standards with the extra cost all the same!

(4) Sutherland's claim that low-income households have been affected by appliance standards in an especially negative way is not supported by a careful examination of the relevant factors.

This paper elaborates on the above points.

[1] S. Meyers, J. McMahon, M. McNeil, X. Liu. Realized and Prospective Impacts of U.S. Federal Efficiency Standards for Residential Appliances. LBNL-49504 (June 2002)

Impact of Appliance Standards on Efficiency Trends

Sutherland correctly states that "Energy use declined in new appliances well before standards came into effect." (p. 6) While this statement is certainly true, it does not at all contradict our argument that standards had an effect on efficiency. For most of the products covered by standards, the time-series data on efficiency of units sold clearly show that standards had an impact (see Appendix 1). The figures in Appendix 1 also show that the trend of significantly improving efficiency seen in the 1973-83 period of energy price increase had in many cases begun to slow by the mid-1980s. One reason for this slowing was that real residential electricity and natural gas prices declined in the mid-1980s (see Figure 8 in Appendix 1). Another reason is that appliance manufacturers had captured the cheapest efficiency gains prior to the mid-1980s.

California set energy efficiency standards starting in the mid-1970s, followed by other states. The first federal appliance standards were announced in 1987. The impact of federal appliance standards in the late 1980s is difficult to assess because state standards were already impacting appliances and many utilities offered consumers incentives to purchase higher-efficiency appliances as part of their energy conservation programs. The effect of federal standards is more evident with the standards that took effect in the mid-1990s and in 2000-01.

The magnitude of the impact of appliance standards is certainly difficult to estimate, since it requires a judgment about what would have happened without standards. The Meyers et al. study mainly relied on trends in efficiency before each standard came into effect to estimate a "without standards" base case for each product. Such an approach is admittedly problematic, as trends can change depending on energy prices and other factors. One could easily assume a "without standards" base case that shows more or less efficiency gain than estimated by Meyers et al.

Sutherland argues that market forces (presumably including utility programs) accounted for a larger share of the observed efficiency gains than estimated by Meyers et al. He cites a study by Newell et al., and says (wrongly) that it "found that perhaps less than one-third of the energy savings in new appliances could be attributed to federal standards"(p. 6).[3] In fact, this statement is not substantiated by the Newell et al. study. The Newell et al. study considered the impact of standards on only two products: room air conditioners and gas water heaters. (Sutherland mentions central air conditioners, but in fact Newell et al. did not run a simulation for this product because their data extended only to 1988, well before the 1992 standard.) Newell et al. estimated that standards accounted for two-thirds of the total change in energy efficiency in the 1973-1993 period for gas water heaters, and one quarter of the total change for room air conditioners (Table VI in Newell et al.). For the latter product, LBNL's energy savings estimates assume that around one-third of the change in efficiency during 1973-1993 was due to standards—close to the estimate of Newell et al.[4]

It is also worth noting that the Newell et al. study only considered the impact of the standards that took effect for room air conditioners and water heaters in 1990. For Sutherland to draw

[3] Richard Newell, Adam Jaffe, and Robert Stavins, The Induced Innovation Hypothesis and Energy-Saving Technological Change, *Quarterly Journal of Economics*, August 1999.

[4] National time-series data on energy efficiency are not available for water heaters.

conclusions on the impact of the 14 separate federal standards that became effective in the 1990-2001 period, and another 4 standards that will become effective in 2004-2007, based on an average of two data points, is clearly inappropriate.

Discount Rates

Sutherland takes issue with the use of a 7% real discount rate to value the future benefits of appliance standards. The 7% discount rate is based on guidance issued by the Office of Management and Budget (OMB) in Circular No. A-94 (Revised), which states (section 8): "In general, public investments and regulations displace both private investment and consumption. … Constant-dollar benefit-cost analyses of proposed investments and regulations should report net present value and other outcomes determined using a real discount rate of 7 percent. This rate approximates the marginal pretax rate of return on an average investment in the private sector in recent years."[5] OMB's guidance reflects the view that – from a national perspective – the opportunity cost of capital invested to improve appliance efficiency is best approximated by using the return on an average investment in the private sector. In DOE's analyses of the national economic impacts of equipment energy efficiency standards, it relies on the OMB guidance.

Some prominent economists contend that an even lower discount rate is more appropriate. As the OMB guidance notes, regulations such as energy efficiency standards displace both private investment and consumption. Economist Kenneth Arrow notes that "Since consumption is much larger than investment [in the economy], it is reasonable to assume that the appropriate hurdle rate should be closer to the consumption rate… Most estimates of the rate of return on consumption are on the order of 3 or 4 percent."[6] In fact, in 2003 the OMB acknowledged this line of reasoning and advised Federal agencies to use a 3% discount rate to express the "social rate of time preference" when regulation primarily affects private consumption (e.g., through higher consumer prices for goods).[7]

Though Sutherland does not say so directly, he apparently believes that the valuation of benefits of appliance standards should use the private discount rates of the consumers affected by standards rather than an average national discount rate. He approvingly quotes two economists who contend that "There is little rationale for the government to discount future costs and benefits of any particular project or program differently than the private market." In fact, OMB's selection of a discount rate for public investments and regulations is based on the discount rate for the private sector as a whole, with the exception that the national perspective does not consider tax impacts while the private sector perspective does.

Sutherland suggests that the discount rate for a regulation should be based on the opportunity cost of capital for the affected parties. In fact, when DOE/LBNL analyzes the impact of standards on consumers' life-cycle cost of owning and operating a household appliance, it does make use of consumer discount rates that reflect the opportunity cost of capital for households. DOE/LBNL's estimates of consumer discount rates are based on a detailed analysis of actual household equity and debt portfolios and actual return and interest rates. For each household in a large representative sample, the estimated rate reflects the marginal opportunity for either equity

[5] See http://www.whitehouse.gov/omb/circulars/a094/a094.html#9.

[6] Kenneth Arrow, A Comment on Cooper, *World Bank Research Observer*, 2000, 15(2).

[7] OMB, Circular A-4, Sept. 17, 2003, p. 33.

investment or debt reduction. For instance, for DOE's recent rulemaking on central air conditioners, the average estimated consumer discount rate was 5.6% real.[8] These consumer discount rates are used to calculate life-cycle cost impacts to individual consumers, while the OMB rate of 7% real is used to calculate net present value of projected national impacts (reductions in energy expenditures over the lifetime of the equipment and increases in equipment purchase and installation costs).

Sutherland cites two papers that argued that the irreversible nature of energy efficiency investments calls for use of a higher discount rate than the return on stocks, which are liquid investments. Irreversibility is a characteristic of most investments in capital or durable goods, whether by households or business firms. If the investment turns out unfavorable, sunk costs may be difficult to recover. First, it is not clear that an irreversible investment, whether in energy efficiency or something else, is inherently riskier than a liquid investment in stocks. Irreversibility, degree of risk, and liquidity are distinct issues that Sutherland is mixing together. Second, it is not clear that the irreversibility of energy efficiency investments should raise their discount rates substantially. We return to this issue below.

Sutherland states that "the literature indicates that an appropriate discount rate for residential energy efficiency investments is at least 21-28 percent, if not higher." He then cites a review of a number of studies of consumer behavior from the early 1980s that calculated so-called "implicit discount rates" and found them to range from 3% to 100%, depending on the type of appliance and household income level.[9] Implicit discount rates are the rates that describe consumers' choices relating to energy-using equipment; consumers behave *as if* they had used a specific rate in terms of trading off first cost with future energy cost savings. In other words, if an efficient alternative was available that offered a high rate of return on the incremental investment, but consumers – for whatever reason – purchased less efficient designs, the "implicit discount rate" reflects the rate of return foregone. This type of calculation provides useful information about consumer behavior, but the result is not the same as the opportunity cost of capital, which is the textbook definition of the discount rate (as Sutherland himself cites on p. 7). Indeed, the high implicit discount rates are evidence of the very market failures that standards are designed to correct, such as lack of reliable information. The studies of implicit discount rates mostly considered behavior during a period when energy performance labeling for products studied was either non-existent or not very helpful for consumers.

Economists, including Sutherland himself and several others cited by him, have long been at pains to explain implicit discount rates (or revealed firm hurdle rates) for energy-efficiency investments that exceed market rates for borrowing or saving, in some cases by orders of magnitude.[10] As Sutherland notes, the question of the 'right' discount rate "... hinges on the potential yield for alternative investments and the risk of the investment in question."

In his 1991 paper, Sutherland attempted to apply the logic of the Capital Asset Pricing model to

[8] The 5.6% rate is after taxes, and adjusted for inflation. For a small percentage of households with large amounts of credit card debt, the discount rate can be over 20%, but these are in the minority.

[9] Kenneth Train, "Discount Rates in Consumers' Energy-Related Decisions: A Review of the Literature," *Energy* 10, no. 12 (December 1985): 1251.

[10] The hurdle rate refers to the rate of return required to explain or justify investment, usually by firms.

demonstrate that high hurdle rates were in fact 'rational.'[11] However, as Metcalf (1994) explains, Sutherland's logic was exactly reversed.[12] Because returns to energy-efficiency investments provide a good hedge against potential losses from other investments, the energy-efficiency 'risk premium' should in fact be negative - that is, a rational consumer should apply a lower hurdle rate to energy efficiency than to other investments. This finding, among other things, prompted Metcalf, as well as Hassett and Metcalf (1993),[13] to attempt an explanation in terms of 'irreversibility' or option values associated with energy-efficiency investments. While Sutherland cites this work, he fails to point out that it too dramatically fails to explain high energy-efficiency hurdle rates. As Sanstad et al. (1995) point out, the hurdle rate 'predicted' by Hassett and Metcalf, using this irreversibility argument, is in fact 6.8%.[14] Moreover, the irreversibility argument falls well short of rationalizing implicit discount rates in the range reported in the literature, including the review by Train.

Costs and Benefits Reconsidered

Sutherland attempts to estimate the net benefits or costs of appliance standards by reducing the LBNL estimate of energy savings from standards by half and by applying discount rates ranging from 7% to 35% to the associated monetary costs and benefits. The above sections show that Sutherland's assumptions rest on a very weak foundation. But Sutherland also makes a basic error of reasoning that renders his own calculations wrong. By assuming that half of the energy savings estimated by LBNL occurs as a result of market forces rather than from appliance standards, Sutherland implicitly assumes that the relevant appliance purchases would have occurred in the "without standards" base case. He reduces the present value of total energy cost savings estimated by LBNL ($236 billion) to $118 billion (in the 7% discount rate case). But he continues to use the same figure of $87.5 billion for the investment by consumers in energy efficiency. If half of the energy cost savings would have occurred in the "without standards" base case, then half of the consumer investment must also be moved to the base case, and not charged to standards.[15]

After making this correction, the consumer impacts of standards still have a significant positive net present value even if one reduces the LBNL impact estimate by half and uses a discount rate of 25% (see Table 1).

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[11] Ronald J. Sutherland, "Market Barriers to Energy-Efficient Investments," *Energy Journal* 12, no. 3 (1991): 15-34.

[12] Gilbert Metcalf, Economics and rational conservation policy, *Energy Policy* (1994), Vol. 22 (10) 819-825.

[13] Kevin Hassett and Gilbert Metcalf, "Energy Conservation Investment: Do Consumers Discount the Future Correctly?" *Energy Policy* 21, no. 6 (June 1993): 710-716.

[14] Alan Sanstad, Carl Blumstein, and Steven Soft, "How High Are Option Values in Energy-Efficiency Investments?" *Energy Policy* 23, no. 9 (1995): 739-43.

[15] Note that the column labeled "PV of Investment" in Table 3 of Sutherland's paper should be "PV of Consumer Energy Cost Savings," and the last column should be "Net PV of Savings Minus Investment."

Table 1. Cumulative NPV of Consumer Costs and Savings Associated with Federal Appliance Standards (billion 2001$)

Discount Rate[1]	Standards Impact Estimated by LBNL[2]	Standards Impact Assuming Half of LBNL Estimate[3]
7%	152	76
10%	104	52
15%	66	33
20%	49	25
25%	41	20

[1] The discount rate is applied to net savings (real) in each year in 2002-2050. For net savings in 1987-2000, we applied an interest rate of 3%/year (an "inverse discounting" to reflect the fact that the present value of savings in the past is greater than their value in the year in which they occurred). See p. 34 in Meyers et al. for further discussion.
[2] See Meyers et al.
[3] Assumes that in each year of the 1987-2050 period, the standards are credited with half of the extra cost and operating cost savings estimated by Meyers et al.

It is also worth noting that the estimates of the incremental consumer cost of higher-efficiency appliances made by Meyers et al. may well be too high. These estimates were based on prospective engineering analysis and estimation of markups in distribution channels conducted by DOE/LBNL before the standards were enacted. An analysis of actual market prices of refrigerators before and after the 1990 and 1993 Federal standards found that the standards did not result in an increase in "quality-adjusted" prices to the consumer.[16] Two possible explanations for this phenomenon are: (1) once faced with the reality of standards, appliance manufacturers came up with production strategies that resulted in less extra cost than indicated by the prospective engineering analysis, and (2) regardless of manufacturing costs, consumers may have been protected from retail price increases due to the growing role of large companies in appliance sales. Dale et al. (2003) found that general and directed technological change has been the key factor that has allowed appliance prices to continue falling over time (in real terms) even as efficiency has significantly improved.[17] They also observed that changes in retail markups and/or economies of scale in production of more efficient appliances may also have contributed to declines in their price.

Impact of Appliance Standards on the Poor

The final section of Sutherland's paper argues that low-income households have very high discount rates and thus end up with higher overall costs when standards force them to purchase appliances with higher energy efficiency.

[16] Lorna Greening, Alan Sanstad, James McMahon, "Effects of Appliance Standards on Product Price and Attributes: An Hedonic Pricing Model," *Journal of Regulatory Economics*, 11:181-194 (1997).

[17] Larry Dale, Camille Antinori, Michael McNeil, Jim McMahon, "Retrospective Analysis of Appliance Efficiency and Retail Price Trends." Conference paper, 3rd International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL'03), September 2003.

Sutherland cites a number of studies from the 1980s that suggest that low-income households have implicit discount rates in excess of 30% with respect to purchase of major appliances. As mentioned above, these implicit discount rates are not equivalent to the opportunity cost of capital. Sutherland argues that low-income households do not have the opportunity to invest in securities or similar assets, "but instead must forgo present consumption of basic necessities of life." This characterization is highly questionable except for the very poorest households who would be unlikely to purchase new major appliances in the first place (because they are renters or would likely purchase used appliances). The more likely opportunity cost for those low-income households who do purchase new appliances is the rate on their credit card, or if they qualify, on an installment loan. Such rates typically range from 5-10% for dealer installment loans to 15-18% (real) for credit cards.

Even if one accepts the argument that analysis of the impacts of appliance standards on low-income households should use discount rates of 30%, it is not clear that these households are hurt by a standard. As mentioned above, appliance prices have been declining even as efficiency has increased. Thus, a low-income household buying an appliance that meets a standard might actually pay little more for this model than it would have paid for a less efficient one.

Sutherland presents arguments in principle, but no data regarding the impact of standards on low-income households. Analysis of the impact of appliance standards on low-income households is complicated because around half of such households are renters[18] and thus are less likely to purchase major appliances. In theory, the landlord might pass on the higher cost of a more efficient appliance in the rent, but since the monetary amounts are relatively small, such pass-through may not occur. Among those low-income households that are homeowners, purchase rates for discretionary appliances (such as freezers and dishwashers) are probably very low.

Sutherland goes on to argue that the main effect of efficiency standards is to remove the least efficient products from the market, and that these removed products would most likely have been purchased by low-income households. Therefore, he contends, most of the impact of appliance standards falls on low-income households. Such a characterization of the effect of Federal appliance standards does not match the actual pattern for at least several appliances. Analysis of the characteristics of models on the market before and after the effective date of standards for refrigerators, room air conditioners, and gas furnaces indicates that the standards appear to have stimulated a broader shift in the efficiency of manufacturer offerings, and not merely removal of the least efficient products from the market.[19]

Conclusion

Sutherland's paper purports to show that Federal appliance standards have and will cost consumers money rather than saving billions of dollars. This review shows that:

1. Sutherland's assumption that standards have saved and will save only half as much as previously estimated is based on a misreading of actual trends in appliance efficiency and on inappropriate use of an econometric analysis of appliance efficiency.

[18] According to data from recent American Housing Surveys by the Census Bureau.

[19] Steve Meyers, Efficiency of Appliance Models on the Market Before and After DOE Standards, Lawrence Berkeley National Laboratory, LBNL-55509, June 2004.

2. Sutherland's application of discount rates ranging up to 35% contradicts the guidance on cost-benefit analysis from the White House OMB, and has very little support in the mainstream economic literature.

3. Sutherland makes a basic error of reasoning in his calculations: he reduces the estimated savings from standards by 50% (suggesting that many consumers would have bought more efficient appliances without standards), but he does not make a corresponding adjustment in the consumer investment in efficiency. That is, his calculation implies that standards were not responsible for much of the purchase of more efficient appliances, but he charges standards with the extra cost all the same!

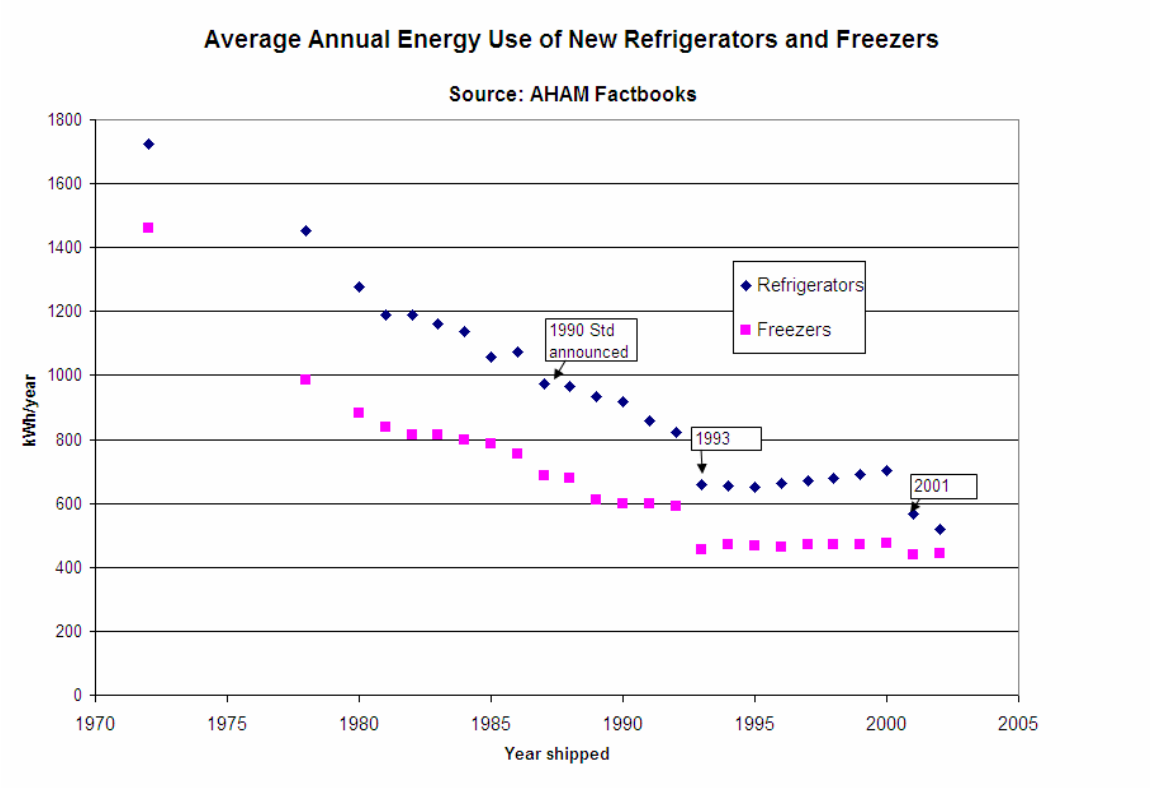
4. Sutherland's claim that low-income households have been affected by appliance standards in an especially negative way is not supported by a careful examination of the relevant factors.

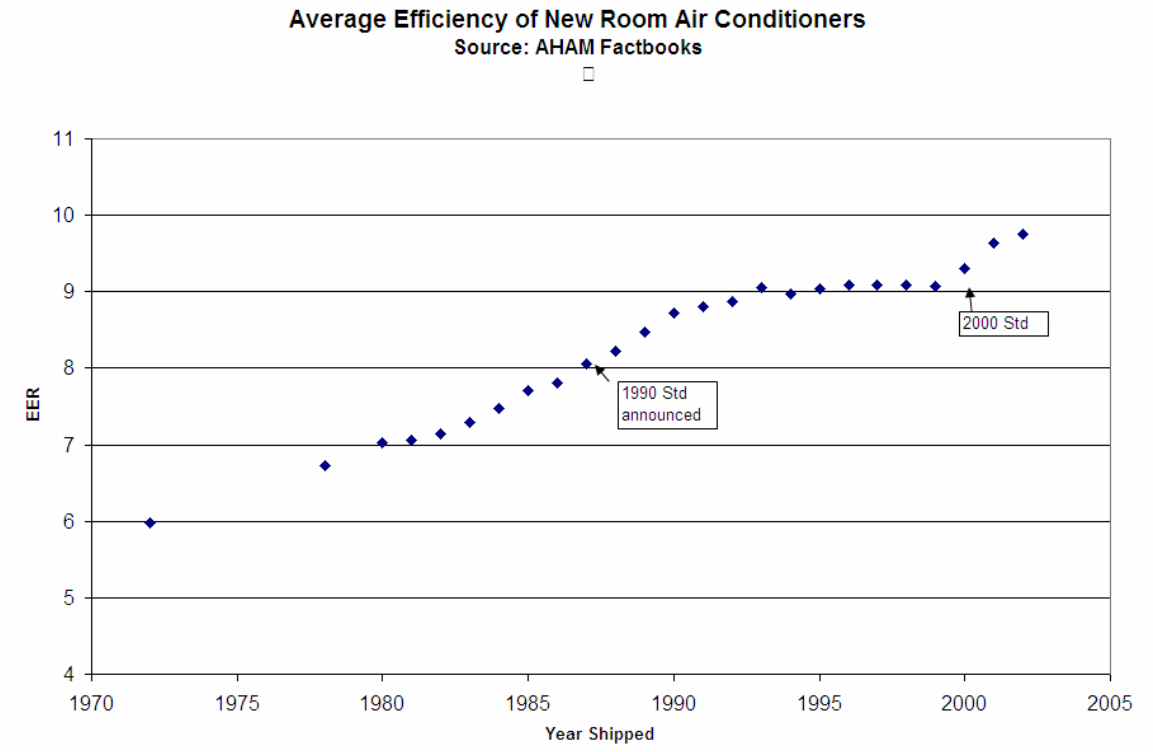
There will always be uncertainty regarding the impact of standards that influence a complex national market over time. Future policy development will benefit from continued careful evaluation of the impact of standards that have already been promulgated. While the LBNL study criticized by Sutherland is hardly the final word on the subject, its basic conclusion that appliance standards have and will continue to save substantial amounts of energy and money is sound.

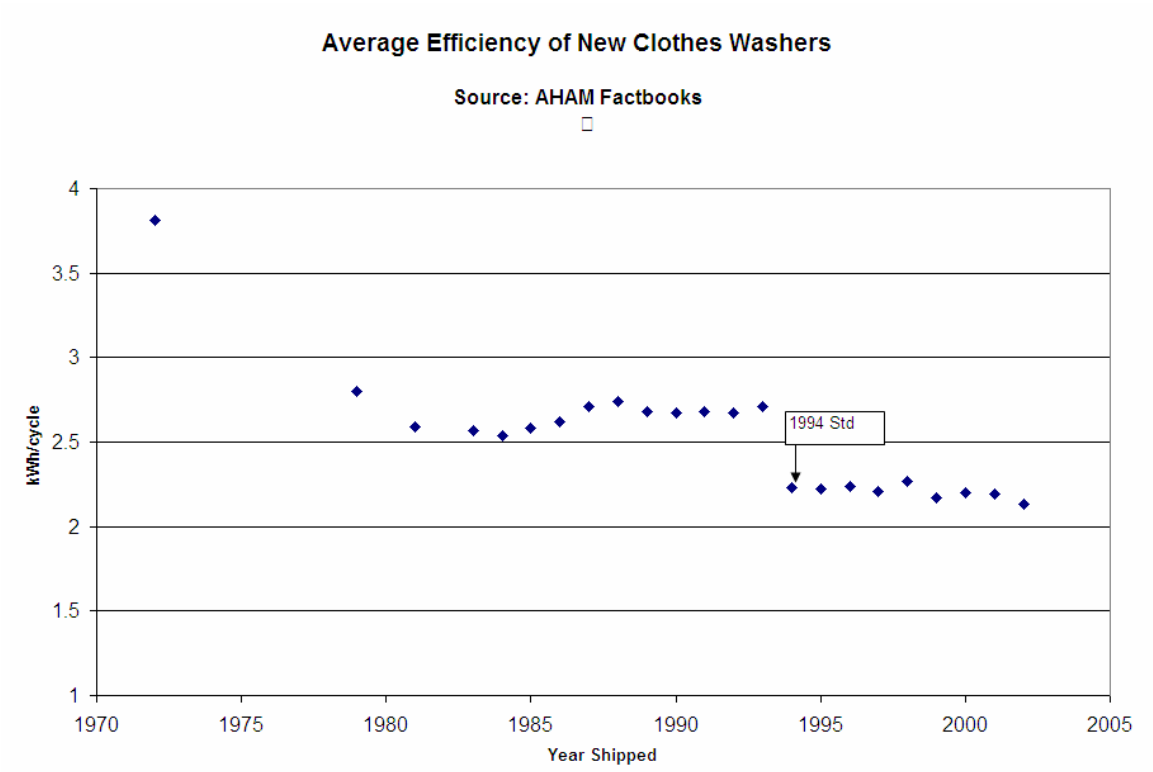
Acknowledgements

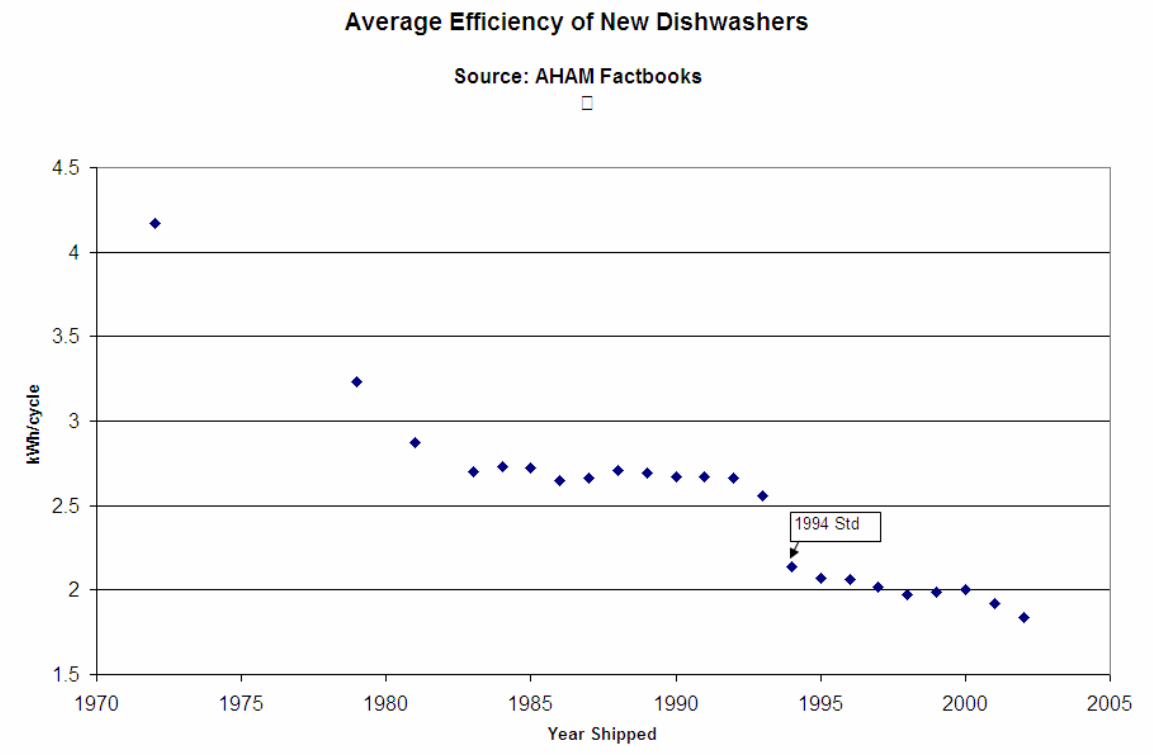
We acknowledge the contributions of Alan Sanstad and Larry Dale of LBNL to the discussion of discount rates.

Appendix 1. Historical Efficiency Trends for Major Appliances in the U.S.



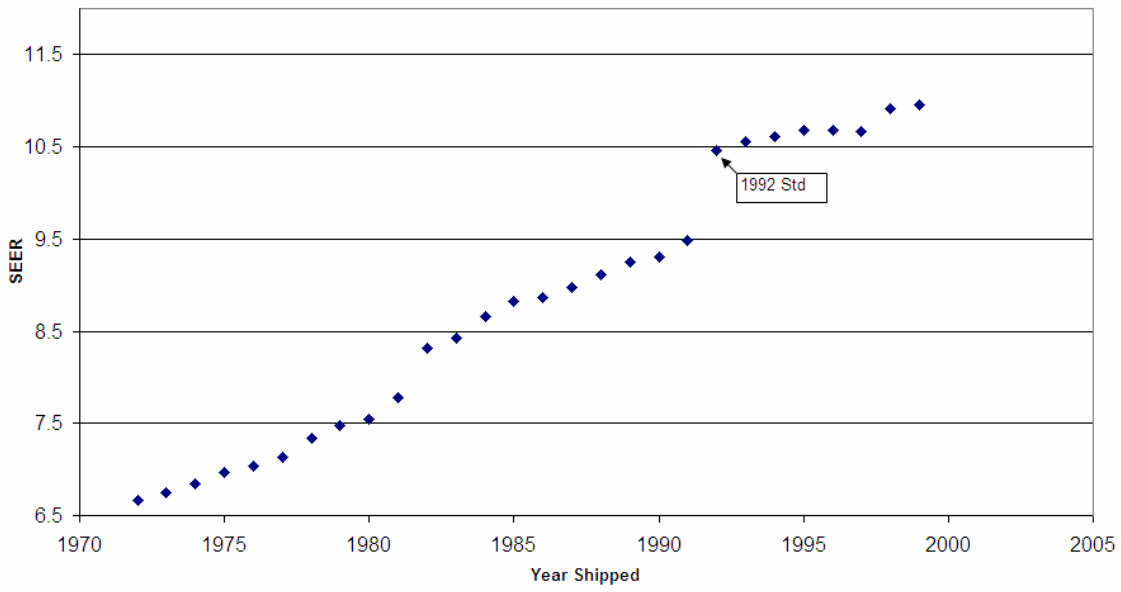



Average Efficiency of New Clothes Washers
Source: AHAM Factbooks
kWh/cycle
4
3.5
3
2.5
2
1.5
1
1970
1975
1980
1985
1990
1995
2000
2005
Year Shipped
1994 Std


Average Efficiency of New Dishwashers
Source: AHAM Factbooks
kWh/cycle
4.5
4
3.5
3
2.5
2
1.5
1970
1975
1980
1985
1990
1995
2000
2005
Year Shipped
1994 Std

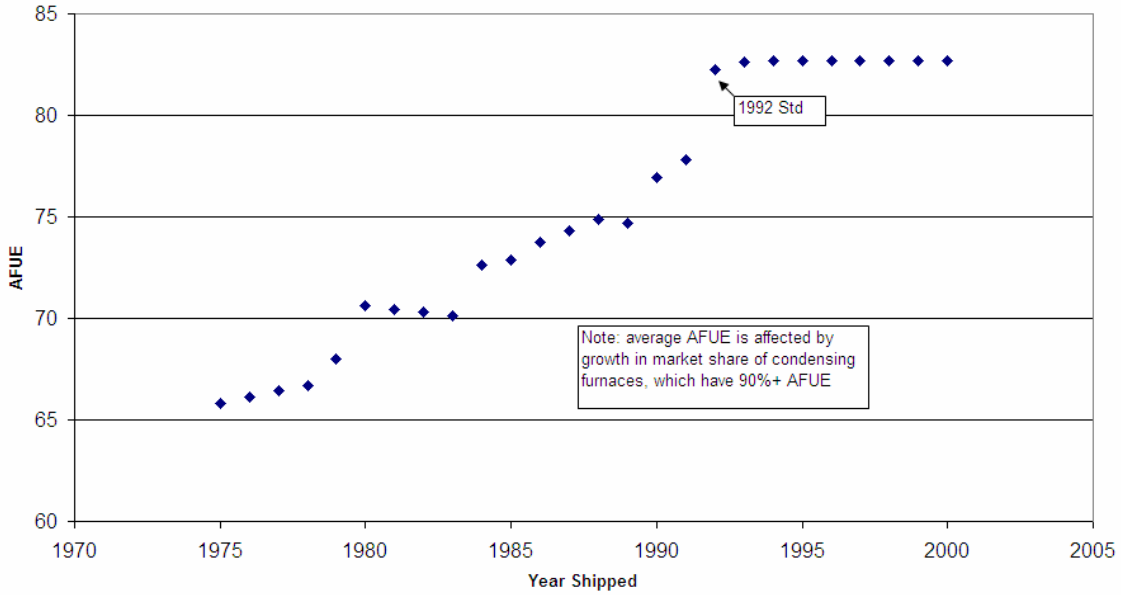
Average Efficiency of Central Air Conditioners

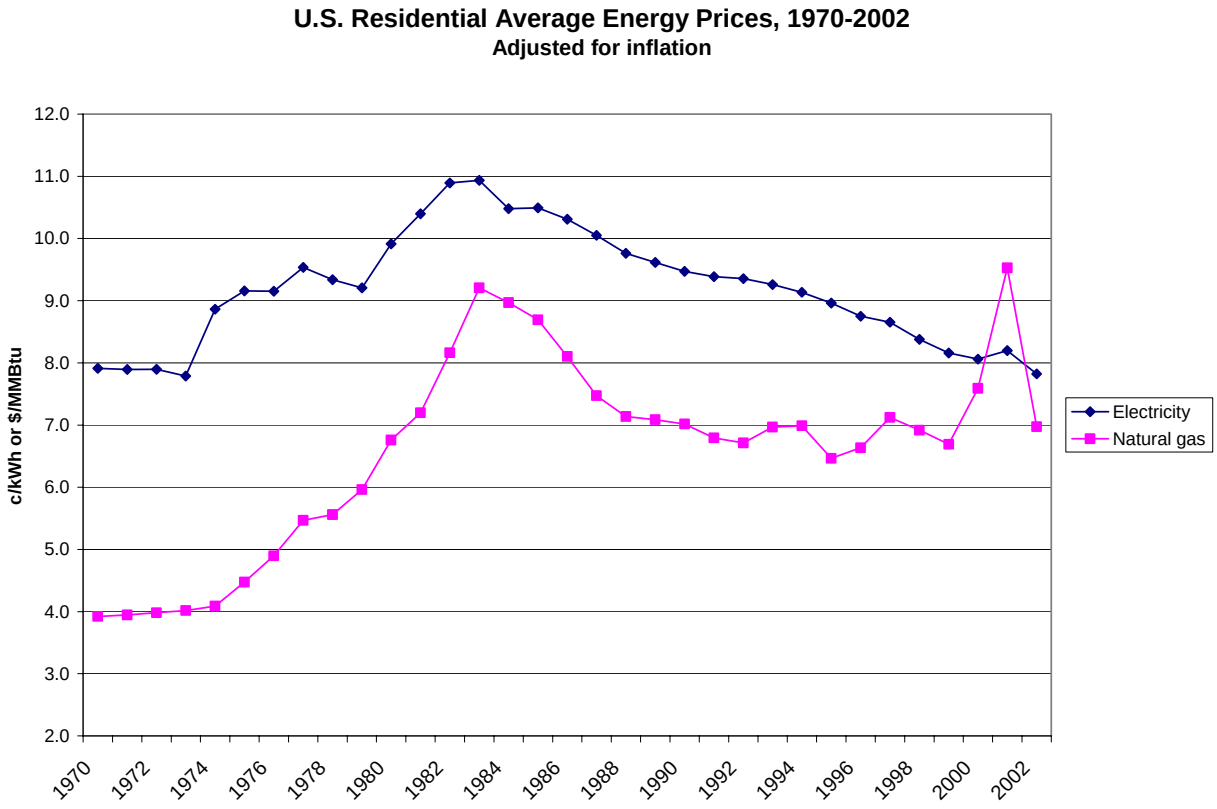
Source: AHAM Factbooks



Average Efficiency of Gas Furnaces

Source: GAMA (some years interpolated)




U.S. Residential Average Energy Prices, 1970-2002
Adjusted for inflation
c/kWh or $/MMBtu
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
Electricity
Natural gas